CLAIMS

1. An optical coupler which comprises:

   (a) a bundle of a plurality of multimode fibers having a few-mode fiber in the centre, said few-mode fiber being a signal fiber through which an optical signal is transmitted;

   (b) a large area core double clad fiber (LACDCF) having an inner cladding and an outer cladding with a lower refractive index, and having an end portion terminating with an input end the inner cladding of which has a predetermined circumference, into which input end of the LACDCF the optical signal is to be transmitted;

   (c) said bundle having a fused end portion with an output end having a periphery that fits within the circumference of the inner cladding of the input end of the LACDCF; and

   (d) said output end of the bundle being aligned and spliced with the input end of the LACDCF in such a way as to preserve fundamental mode transmission from the few-mode fiber to the LACDCF.

2. An optical coupler according to claim 1, in which the outer cladding of the LACDCF ia a polymer cladding and said polymer outer cladding is removed from the end portion of the LACDCF.

3. An optical coupler according to claim 1, in which the multimode fibers are tapered before being fused at the output end, in order to fit within the circumference of the inner cladding of the input end of the LACDCF.

4. An optical coupler according to claim 3, in which the multimode fibers are tapered and fused in such a way as not to affect the fundamental mode transmission

in the core of the few-mode fiber.

5. An optical coupler according to claim 3, in which the tapering of the multimode fibers reduces the core of the few-mode fiber to the fundamental mode size near the output end of the bundle, when said core had been expanded prior to bundling.

6. An optical coupler according to claim 1, in which the few-mode fiber at the output end is a fiber with a core expanded from a single mode fiber.

7. An optical coupler according to claim 1, in which the plurality of multimode fibers is placed essentially symmetrically around the few-mode fiber within the bundle.

8. An optical coupler according to claim 1, in which at least one of the plurality of multimode fibers in the bundle is replaced by a dummy fiber.

9. A method of forming an optical coupler, which comprises:

(a) bundling a central few-mode fiber with a plurality of surrounding multimode fibers so that the surrounding multimode fibers are positioned essentially symmetrically around the central few-mode fiber, thereby forming a bundle of said fibers having an output end;

(b) providing a large area core double clad fiber (LACDCF) having an inner cladding and an outer cladding with a lower refractive index, and having an end portion terminating with an input end where the inner cladding of the LACDCF has a given circumference;

(c) fusing the output end of the bundle so that its periphery fits within the circumference of the inner cladding of the input end of the LACDCF; and

(d) splicing the fused output end of the bundle to the input end of the LACDCF in such a manner that the core of the few-mode fiber is precisely modally aligned with the core of the LACDCF so as to preserve fundamental mode transmission from the few-mode fiber to the LACDCF.

10. Method according to claim 9, in which the outer cladding of the LACDCF is a polymer cladding and the method includes removing said polymer outer cladding from the end portion of the LACDCF prior to splicing.

11. Method according to claim 9, in which the multimode fibers at the output end of the bundle are tapered prior to being fused.

12. Method according to claim 11, in which the tapering is done according to the following maximum taper ratio:

$$R = \rho_o / \rho_i = NA_{MM} / NA_{DCF}$$

where R is the maximum taper radio

ρ_o is the final diameter of the multimode fiber

ρ_i is the initial diameter of the multimode fiber

NA_{MM} is the numerical aperture of the multimode fiber

NA_{DCF} is the numerical aperture of the LACDCF inner cladding waveguide.

13. Method according to claim 11, in which the tapering of the multimode fibers followed by fusing of the bundle is done so as not to affect the modal size of the core of the few-mode fiber.

14. Method according to claim 11, in which the tapering of the multimode fibers followed by fusing of the bundle decreases the modal size of the core of the few-mode fiber, when said core had been expanded prior to bundling.

15. Method according to claim 9, in which the few-mode fiber has a core near the output end of the bundle, which is expanded from an initial single-mode fiber core.

16. Method according to claim 15, in which the expansion is done by means of a mode converter to increase the size of the core.

17. Method according to claim 15, in which the expansion is done by heating to a high temperature such that germanium present in the core diffuses into the cladding, thereby increasing the size of the core and of the mode.

18. Method according to claim 9, in which the cores of the few-mode fiber and of the LACDCF are precisely modally aligned by launching the fundamental mode of the few-mode fiber while monitoring the modal content at the input end of the LACDCF by means of a near field measurement device and aligning the output end of the bundle and the input end of the LACDCF until a Gaussian mode field is obtained.

19. Method according to claim 18, in which the LACDCF is kept straight or under a small tension, when monitoring the modes by the near field measurement device, and the measurement is done at or near operational wavelength.

20. Method according to claim 19, in which the coupler is packaged by bonding it to a suitable substrate to preserve the alignment of the components.